Coherence Time Effects on J/ψ Production and Suppression in Relativistic Heavy Ion Collisions *

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Ultrarelativistic heavy ion collisions offer the tantalizing possibility of forming and studying a new form of matter predicted by QCD: the quark-gluon plasma. A vigorous experimental program has existed at the CERN SPS for more than ten years. Several experimental signals have been put forward as candidates for QCD plasma signatures. Of those, the most famous is probably that of J/ψ suppression in nucleus-nucleus collisions. The theoretical and experimental activity that have followed this seminal suggestion have been considerable as the disappearance of the J/ψ can directly be linked to deconfinement and Debye screening in the plasma.

Before an experimentally observed J/ψ suppression pattern is interpreted as an unambiguous signal of the existence of a quark-gluon plasma, it is imperative to rule out all competing explanations of purely hadronic origin. In almost all considerations involving heavy ion collisions at any energy, the issues of dynamics and elementary processes remain intimately connected and inseparable.

We have investigated nucleus-nucleus collisions with a model called LEXUS that incorporates the coherence time associated with the emission of soft quanta in hadronic interactions. This approach translates into lost energy for the formation of hard radiation, such as high-mass Drell-Yan pairs and J/ψ. We have obtained results in quantitative agreement with experimental data for the reaction S on U at 200A GeV/c. The ratio of J/ψ to Drell-Yan cross sections as a function of collision centrality, as well as the total absolute cross sections are reproduced by our model. Therefore, we can understand Drell-Yan and J/ψ formation in pA and S+U collisions in terms of the same physics. However, this model fails to reproduce measurements done in connection with the heavier Pb+Pb system as shown in the following figure.

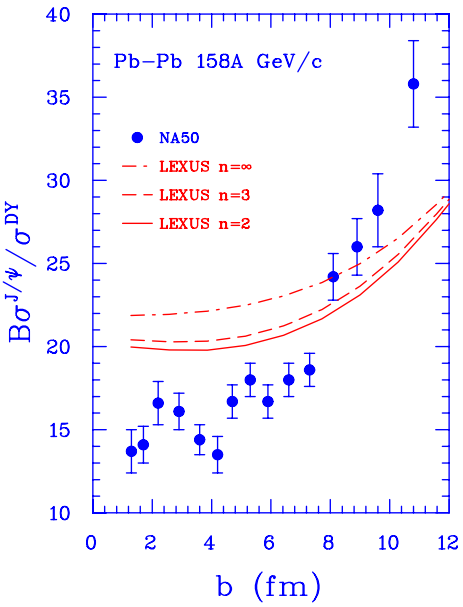

Figure 1: Same as Fig.1, except that this is for the heavier system. The data is from NA50.

Several points still need to be clarified. It will be very instructive to repeat this analysis in partonic variables including nuclear shadowing. A systematic exploration of the freedom allowed by the most recent high-precision pA measurements is called for and is underway. Nevertheless, if the Pb+Pb data stand the test of time, it does not seem possible to escape the conclusion that J/ψ suppression is caused by high energy density. Whether it is due to absorption on hadronic comovers or quark-gluon plasma remains an open and exciting question.

Footnotes and References

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